Center Independent Research & Development: GSFC IRAD

Slosh Analysis and Integration with Freespace

Completed Technology Project (2012 - 2013)

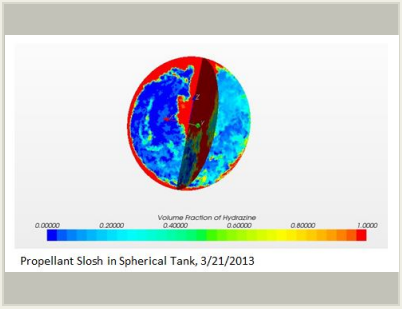
Project Introduction

Being able to model propellant slosh within propellant tanks is extremely important for the tight control of a spacecraft. The Slosh Analysis and Integration project will develop the capability to model propellant slosh using computational fluid dynamics (CFD) software, STAR-CCM+ and will link these working CFD models to Freespace, an in-house attitude control software. By accomplishing these goals, future missions will be enabled, traditionally feasible mission costs will be reduced, and troubleshooting tools will be available for on-orbit anomalies.

The broad objective of this project is to accurately model fuel slosh in a low-gravity environment and then connect the fuel slosh model to a simulation environment that will allow for the testing of attitude control algorithms. STAR-CCM+, a commercially available computational fluid dynamics (CFD) software package, is used to model the fuel slosh and output forces, torques, and center of mass position changes due to the fuel slosh. Freespace is used as the simulation environment to test the attitude control algorithms. The Solar Dynamics Observatory (SDO) spacecraft is modeled with mission like maneuvers. SDO was chosen because the spacecraft went into a safe mode due to the attitude control system not being able to accurately point the spacecraft. The forces and torques that caused this problem came from SDO's fuel slosh. Below are listed key accomplishments of this project. CFD modeling of bare SDO tank CFD modeling of SDO tank with static propellant management device (PMD) vanes CFD modeling of SDO tank with deformable PMD vanes Linking of above CFD models to Freepsace Testing of linked CFD models and Freespace with SDO like spacecraft maneuvers

Anticipated Benefits

ICESat2 and OSIRIS-REx will both benfit from this project. These misisons will benefit through the modeling of slosh through the computatoinal fluid dynamics (CFD) program, STAR-CCM+. The force, torque, and center of mass outputs from STAR-CCM+ will be inputted into Freespace or other control algorithms testing environments to provide high fidelity testing of the attitude control algorithms.



CFD Slosh Analysis and Integration with Freespace

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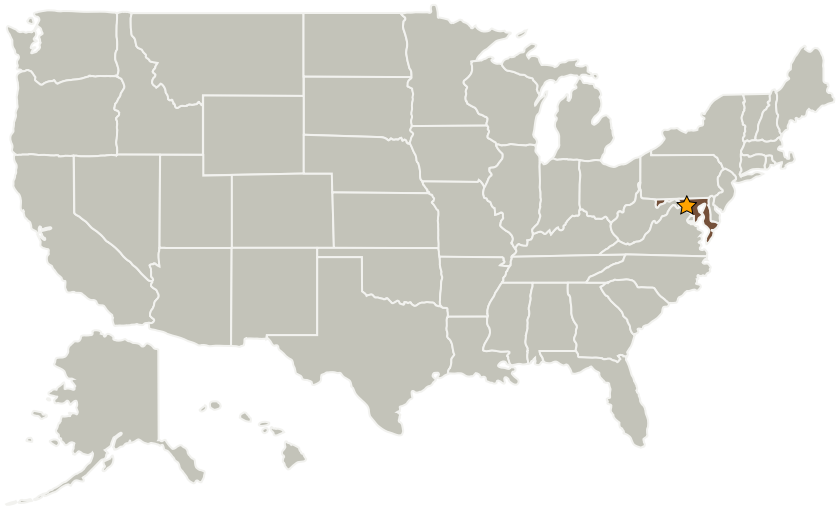
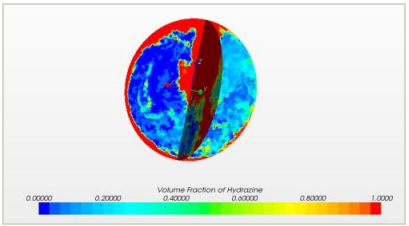
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations
Maryland

Images



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CFD Slosh Analysis and Integration with Freespace
(https://techport.nasa.gov/image/1858)

Organizational Responsibility

Responsible Mission Directorate:
Mission Support Directorate (MSD)

Lead Center / Facility:
Goddard Space Flight Center (GSFC)

Responsible Program:
Center Independent Research & Development: GSFC IRAD

Project Management

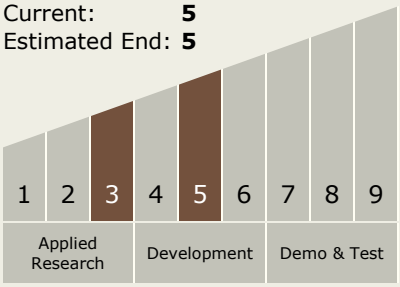
Program Manager:
Peter M Hughes

Project Manager:
John C Adams

Principal Investigator:
David J Benson

Technology Maturity (TRL)

Start: **3**
Current: **5**
Estimated End: **5**



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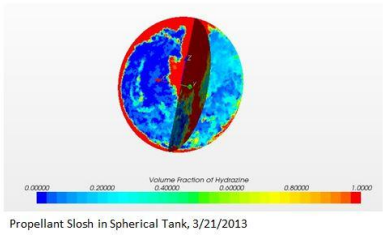

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CFD Slosh Analysis and Integration with Freespace
(https://techport.nasa.gov/image/1859)

Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.1 Chemical Space Propulsion
    - TX01.1.1 Integrated Systems and Ancillary Technologies